

What is claimed is:

- 1 1. A packaged solid state assembly comprising:
 - 2 a) a first ceramic substrate and a second ceramic substrate and at least one
3 solid state device located therebetween, each solid state device
4 comprising a body having a coefficient of thermal expansion and a
5 plurality of conductive contacts on a surface of the body facing the
6 second ceramic substrate;
 - 7 b) the first ceramic substrate comprising:
 - 8 a body having a coefficient of thermal expansion matched to the
9 coefficient of thermal expansion of at least one solid state
10 device, a lower side and an upper side facing the solid state
11 devices;
 - 12 a conductive pad covering the lower side; and
13 one conductive pad connected to each of the solid state devices
14 packaged, each conductive pad being bonded to the upper side
15 of the body and connected to the solid state device with which
16 it is associated, each pad being separated from other metal
17 pads by a distance sufficient to prevent breakdown;
 - 18 c) a second ceramic substrate comprising:
 - 19 a body having a coefficient of thermal expansion matched to the
20 coefficient of thermal expansion of at least one solid state
21 device, a lower side facing the solid state devices, and an
22 upper side;
 - 23 a plurality of conductive pads bonded to the upper side of the body,
24 and

25 a plurality of conductive pads bonded to the lower side of the body, at
26 least one pad for each contact on the solid state devices,
27 facing the solid state devices and connected to the conductive
28 contacts of the solid state device; and

29 a plurality of vias connecting at least some of the conductive pads on
30 the lower side of the body to at least one of the conductive
31 pads on the upper side of the body;

32 d) a plurality of terminals connected to the conductive pads on the upper
33 surface of the second ceramic substrate;

34 e) a strip line comprising an insulating body, a first conductive strip and a
35 second conductive strip, the first conductive strip being connected
36 to a conductive pad on the first ceramic substrate or the second
37 ceramic substrate, and the second conductive strip being connected
38 to a different conductive pad on the first ceramic substrate or the
39 second ceramic substrate; and

40 f) a first encapsulant having a coefficient of thermal expansion matched to
41 the coefficient of thermal expansion of at least one solid state
42 device, encapsulating the solid state devices between the first
43 ceramic substrate and the second ceramic substrate.

1 2. The assembly of claim 1, wherein the first ceramic substrate is made of aluminum
2 nitride.

1 3. The assembly of claim 1, wherein the second ceramic substrate is made of aluminum
2 oxide.

1 4. The assembly of claim 1, further comprising a second encapsulant covering all of the
2 assembly except for the lower side of the first ceramic substrate and ends of the
3 terminals opposite the second ceramic substrate.

- 1 5. The assembly of claim 1, further comprising a shell covering all of the assembly except
2 for the lower side of the first ceramic substrate and ends of the terminals opposite
3 the second ceramic substrate.
- 1 6. The assembly of claim 5, further comprising a second encapsulant inside the shell.
- 1 7. The assembly of claim 1, further comprising a heat sink coupled to the lower side of the
2 first ceramic substrate.
- 1 8. The assembly of claim 1, further comprising at least one conductor connecting a
2 conductive pad on the first ceramic substrate and a conductive pad on the second
3 ceramic substrate.
- 1 9. A package for at least one solid state device, each solid state device comprising a body
2 having a coefficient of thermal expansion and a plurality of conductive contacts,
3 the package comprising:
 - 4 a) a first ceramic substrate and a second ceramic substrate, spaced apart a
5 sufficient distance for at least one solid state device to be located
6 therebetween, the conductive contacts on the solid state device
7 facing the second ceramic substrate;
 - 8 b) the first ceramic substrate comprising:
 - 9 a body having a coefficient of thermal expansion matched to the
10 coefficient of thermal expansion of at least one solid state
11 device, a lower side and an upper side facing the solid state
12 devices;
 - 13 a conductive pad covering the lower side; and
 - 14 one conductive pad for each of the solid state devices packaged, each
15 conductive pad being bonded to the upper side of the body
16 and located so as to be adjacent to the solid state device with
17 which it is associated, each pad being separated from other
18 metal pads by a distance sufficient to prevent breakdown;

- 19 c) a second ceramic substrate comprising:
- 20 a body having a coefficient of thermal expansion matched to the
21 coefficient of thermal expansion of at least one solid state
22 device, a lower side facing the solid state devices and an
23 upper side;
- 24 a plurality of conductive pads bonded to the upper side of the body,
25 and
- 26 a plurality of conductive pads bonded to the lower side of the body, at
27 least one pad for each contact on the solid state devices,
28 facing the solid state devices and connected to the conductive
29 contacts of the solid state device; and
- 30 a plurality of vias connecting at least some of the conductive pads on
31 the lower side of the body to at least one of the conductive
32 pads on the upper side of the body;
- 33 d) a plurality of terminals connected to the conductive pads on the upper
34 surface of the second ceramic substrate; and
- 35 e) a strip line comprising an insulating body, a first conductive strip and a
36 second conductive strip, the first conductive strip being connected
37 to a conductive pad on the first ceramic substrate or the second
38 ceramic substrate, and the second conductive strip being connected
39 to a different conductive pad on the first ceramic substrate or the
40 second ceramic substrate; and
- 41 such that when at least one solid state device is mounted in the package, the
42 space between the first ceramic substrate and the second ceramic
43 substrate is filled with a first encapsulant having a coefficient of
44 thermal expansion matched to the coefficient of thermal expansion
45 of at least one solid state device, encapsulating the solid state
46 devices.

11 a plurality of conductive pads bonded to the lower side of the body, at
12 least one pad for each contact on the solid state devices,

13 a plurality of vias connecting at least some of the conductive pads on
14 the lower side of the body to at least one of the conductive
15 pads on the upper side of the body; .

16 b) placing the solid state devices on the lower side of the second ceramic
17 substrate, with the contacts of the solid state devices in alignment
18 with the conductive pads on the lower side of the second ceramic
19 substrate;

20 c) connecting the contacts of the solid state device to the conductive pads
21 on the lower side of the second ceramic substrate;

22 d) assembling the connected solid state devices and second ceramic
23 substrate with a first ceramic substrate comprising:

24 a body having a coefficient of thermal expansion matched to the
25 coefficient of thermal expansion of at least one solid state
26 device, a lower side and an upper side;

27 a conductive pad covering the lower side; and

28 one conductive pad for each of the solid state devices to be packaged,
29 each conductive pad being bonded to the upper side of the
30 body and located adjacent to the solid state device with which
31 it is associated, each pad being separated from other metal
32 pads by a distance sufficient to prevent breakdown;

33 e) connecting the conductive pads on the upper side of the first ceramic
34 substrate to the solid state devices;

35 f) connecting a plurality of terminals to the conductive pads on the upper
36 surface of the second ceramic substrate;

37 g) connecting a strip line comprising an insulating body, a first conductive
38 strip and a second conductive strip, to the conductive pads on the
39 first ceramic substrate and the second ceramic substrate; and

40 h) filling the space between the first ceramic substrate and the second
41 ceramic substrate with a first encapsulant having a coefficient of
42 thermal expansion matched to the coefficient of thermal expansion
43 of at least one solid state device, encapsulating the solid state
44 devices using a mold.

1 18. The method of claim 17, in which the filling step (h) encapsulating the solid state
2 device between the two ceramic substrates is done under vacuum using a mold.

1 19. The method of claim 17, further comprising the step, after step (h) of :

2 i) encapsulating the assembled upper side of the first ceramic substrate, the
3 second ceramic substrate, solid state devices, strip line, and
4 terminals in a second encapsulant using a mold, leaving the lower
5 side of the first ceramic substrate, an outer portion of each of the
6 terminals and an outer portion of the strip line free of encapsulant.

1 20. The method of claim 19, in which the encapsulation steps (h) and (i) comprise the
2 steps of:

3 1) adhering the conductive pad on the lower side of the second conductive
4 pad against a first part of a mold with a removable adhesive;

5 2) sealing the first part of the mold to a second part of the mold, enclosing
6 the first ceramic substrate, solid state devices, second ceramic
7 substrate, and heat sink within the mold;

8 3) vacuum filling the mold with the first encapsulant, producing an
9 encapsulated unit with all parts having similar coefficients of
10 thermal expansion;

11 4) removing the second part of the mold;

5) sealing the first part of the mold against a different second half of the mold;

6) vacuum filling the mold with the second encapsulant forming an encapsulated module; and

7) removing the module from the mold.

21. The method of claim 19, in which the first encapsulant and the second encapsulant are the same, and encapsulation steps (h) and (i) are combined in the steps of:

1) adhering the conductive pad on the lower side of the second conductive pad against a first part of a mold with a removable adhesive;

2) sealing the first part of the mold to a second part of the mold, enclosing the first ceramic substrate, solid state devices, second ceramic substrate, and heat sink within the mold;

3) vacuum filling the mold with the encapsulant, producing an encapsulated unit with all parts having similar coefficients of thermal expansion;

4) removing the module from the mold.

22. The method of claim 17, further comprising the step, after step (h) of covering all of the assembly except for the lower side of the first ceramic substrate and ends of the terminals opposite the second ceramic substrate in a shell.

23. The method of claim 22, further comprising the step of filling the shell with a second encapsulant.

24. The method of claim 17, in which the conductive pads on the first ceramic substrate and the contacts of the solid state device, the terminals and the conductive pads second ceramic, and the conductive strips of the strip-line and the conductive pads on the first ceramic substrate and the second ceramic substrate, are connected by placing a layer of solder between each pad and contact and placing the first

6 ceramic substrate, second ceramic substrate, solid state devices, terminals and strip
7 line in a re-flow oven to melt the solder.

1 25. The method of claim 24, further comprising the step of cleaning to remove flux and
2 other debris.

1 26. The method of claim 24, further comprising the step of controlling temperature and
2 environment at least during steps (a) through (f) to reduce stress.

1 27. The method of claim 17, further comprising the step of mounting the first ceramic
2 substrate to a heat sink.

1 28. The method of claim 17, further comprising the step of connecting at least one
2 conductive pad on the first ceramic substrate to at least one conductive pad on the
3 second ceramic substrate.